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General

Guideline Title

Management of isolated fractures of the axis in adults. In: Guidelines for the management of acute cervical spine and spinal cord injuries.

Bibliographic Source(s)

Ryken TC, Hadley MN, Aarabi B, Dhall SS, Gelb DE, Hurlbert RJ, Rozzelle CJ, Theodore N, Walters BC. Management of isolated fractures of the axis in adults. In: Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery. 2013 Mar;72(Suppl 2):132-50. [103 references] [PubMed](#)

Guideline Status

This is the current release of the guideline.

Recommendations

Major Recommendations

The rating schemes used for the strength of the evidence (Class I-III) and the levels of recommendations (Level I-III) are defined at the end of the "Major Recommendations" field.

Recommendations

Fractures of the Odontoid

Level II

- Consideration of surgical stabilization and fusion for type II odontoid fractures in patients ≥ 50 years of age is recommended.

Level III

- Initial management of nondisplaced type I, type II, and type III odontoid fractures with external cervical immobilization is recommended, recognizing that a decreased rate of union (healing) has been reported with type II odontoid fractures compared with type I or type III odontoid fractures.
- Surgical stabilization and fusion of type II and type III odontoid fractures with dens displacement ≥ 5 mm, comminution of the odontoid fracture, and/or inability to achieve or maintain fracture alignment with external immobilization are recommended.
- If surgical stabilization is elected, either anterior or posterior techniques are recommended.

Traumatic Spondylolisthesis of the Axis (Hangman Fracture)

Level III

- External immobilization as the initial management of traumatic spondylolisthesis of the axis is recommended.
- Surgical stabilization and fusion for the treatment of Hangman fractures in cases of severe angulation of C2 on C3, disruption of the C2-C3 disk space, and/or inability to achieve or maintain fracture alignment with external immobilization are recommended.

Fractures of the Axis Body (Miscellaneous Fractures)

Level III

- External immobilization for the treatment of isolated fractures of the axis body is recommended. Consideration of surgical stabilization and fusion in unusual situations of severe ligamentous disruption and/or inability to achieve or maintain fracture alignment with external immobilization are recommended.
- In the presence of comminuted fracture of the axis body, evaluation for vertebral artery injury is recommended.

Summary

A summary of the recommendations for the acute management of axis fractures is provided in Table 1 and the data supporting the recommendations in this section are provided in Table 2 (please refer to the original guideline document).

Fractures of the Odontoid

There is no Class I medical evidence on the management of patients with acute traumatic odontoid fractures. Class II medical evidence exists indicating that the risk of nonunion of a type II odontoid fracture in patients ≥ 50 years of age is 21 times greater than the incidence of nonunion for younger patients with a similar type II odontoid fracture. Therefore, consideration of surgical stabilization and fusion for type II odontoid fractures in patients ≥ 50 years of age is recommended. Type I, II, and III odontoid fractures are often effectively managed with external cervical immobilization, with the understanding that the failure of external immobilization is significantly higher for type II odontoid fractures. Treatment of type II odontoid fractures with a cervical collar alone or traction followed by cervical collar immobilization may be undertaken but is associated with lower fracture union rates. Class III medical evidence indicates that factors associated with nonunion of type II fractures include age, fracture displacement, secondary loss of reduction, and delays in treatment. Similarly, Class III medical evidence suggests that a change in angulation of the type II odontoid fracture of $\geq 5^\circ$ on lateral radiography taken at 2 weeks after immobilization in a halo device is associated with failure of fusion. Closed reduction of displaced type II odontoid fractures is associated with successful treatment with halo immobilization. Type II and III odontoid fractures should be considered for surgical fixation in patients with dens displacement of ≥ 5 mm, comminution of the odontoid fracture (type IIA), and/or inability to achieve or maintain fracture alignment with external immobilization. The treatment of isolated type I odontoid fractures with cervical immobilization is recommended, resulting in fusion rates approaching 100%. Anterior and posterior surgical fixation and fusion of type II and III odontoid fractures have been reported with fusion rates exceeding 90% with low morbidity. The management of odontoid fractures in elderly patients is associated with increased failure rates, and higher rates of morbidity and mortality irrespective of the treatment offered.

Traumatic Spondylolisthesis of the Axis

There is no Class I or Class II medical evidence in the literature addressing the management of traumatic spondylolisthesis of the axis. Class III medical evidence supports a variety of treatments for these injuries. The majority of Hangman fractures heal with 12 weeks of cervical immobilization with either a rigid cervical collar or a halo immobilization device. Surgical stabilization is an option in the treatment of Hangman fractures and is typically reserved for cases of severe angulation, disruption of the C2-C3 disk space, or inability to establish or maintain fracture alignment with external immobilization.

Fractures of the Axis Body (Miscellaneous Axis Fractures)

There is no Class I or Class II medical evidence in the literature addressing the management of traumatic fractures of the axis body. Class III medical evidence supports the use of external immobilization as the initial treatment strategy for the variety of traumatic fractures of the C2 body.

Definitions:

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

Class	Therapeutic Studies: Investigating the Results of Treatment	Diagnostic Studies: Investigating a Diagnostic Test	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications
I	High-quality randomized controlled	Testing of previously developed	Evidence provided by 1 or more well-designed clinical

Class	Therapeutic Studies: Investigating the Results of Treatment trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	Diagnostic Studies: Investigating a Diagnostic Test diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications studies in which interobserver and intraobserver reliability is represented by a \bar{A} statistic ≥ 0.60 or an intraclass correlation coefficient of ≥ 0.70
	Systematic review ^b of Class I randomized controlled trials (and study results were homogeneous ^c)	Systematic review ^b of Class I studies	
II	Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)	Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} statistic of 0.40–0.60 or an intraclass correlation coefficient of 0.50–0.70
	Prospective ^d comparative study ^e	Systematic review ^b of Class II studies	
	Systematic review ^b of Class II studies or Class I studies with inconsistent results	Study of nonconsecutive patients; without consistently applied reference "gold" standard	
	Case-control study ^g	Systematic review ^b of Class III studies	
	Retrospective ^f comparative study ^e	Case-control study	
	Systematic review ^b of Class II studies		
III	Case series ^h	Poor reference standard	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} statistic of <0.40 or an intraclass correlation coefficient of <0.50
	Expert opinion	Expert opinion	

^aA complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

^bA combination of results from 2 or more prior studies.

^cStudies provided consistent results.

^dStudy was started before the first patient enrolled.

^ePatients treated 1 way (e.g., halo vest orthosis) compared with a group of patients treated in another way (e.g., internal fixation) at the same institution.

^fThe study was started after the first patient was enrolled.

^gPatients identified for the study on the basis of their outcome, called "cases" (e.g., failed fusion), are compared with those who did not have outcome, called "controls" (e.g., successful fusion).

^hPatients treated 1 way with no comparison group of patients treated in another way.

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Isolated fractures of the axis, including:

- Odontoid fractures
- Traumatic spondylolisthesis of the axis (Hangman fractures)
- Fractures of the axis body (miscellaneous axis fractures)

Guideline Category

Management

Treatment

Clinical Specialty

Neurological Surgery

Orthopedic Surgery

Intended Users

Advanced Practice Nurses

Hospitals

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

To update the medical evidence on the treatment of isolated axis fractures since the 2002 guidelines publication

Target Population

Adult patients with isolated fractures of the axis

Interventions and Practices Considered

1. Consideration of fracture type and patient age
2. Surgical stabilization and fusion (posterior or anterior approaches)
3. External cervical immobilization (traction, cervical collar, halo immobilization)

Major Outcomes Considered

- Fusion rate

- Morbidity and mortality

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Search Criteria

A National Library of Medicine (PubMed) computerized literature search from 1966 to 2011 was undertaken using Medical Subject Headings in combination with "spinal cord injury": "axis," "vertebrae," "fracture," and "human." A total of 1181 articles were identified. Those articles focusing on the clinical management of acute traumatic axis fractures were selected for review. The bibliographies of these articles were scanned for additional references to confirm completeness of the literature review. Relevant articles addressing the mechanism of injury or the biomechanics and radiology of the C2 vertebra were considered for inclusion in the scientific foundation of this document.

Number of Source Documents

Forty-six articles not previously included in the original guidelines document were identified, reviewed, and classified using established methodology. Thirty-one articles described the management of odontoid fractures; 10 articles were focused on traumatic spondylolisthesis of the axis; and 5 articles described the treatment of patients with miscellaneous axis fractures.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Rating Scheme for the Strength of the Evidence: Modified North American Spine Society Schema to Conform to Neurosurgical Criteria as Previously Published and for Ease of Understanding and Implementation: Levels of Evidence for Primary Research Question^a

Class	Therapeutic Studies: Investigating the Results of Treatment	Diagnostic Studies: Investigating a Diagnostic Test	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications
I	High-quality randomized controlled trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic ≥ 0.60 or an intraclass correlation coefficient of ≥ 0.70
	Systematic review ^b of Class I randomized controlled trials (and study results were homogeneous ^c)	Systematic review ^b of Class I studies	
II	Lesser-quality randomized controlled trial (e.g., <80% follow-up, no blinding, or improper randomization)	Development of diagnostic criteria on consecutive patients (with universally applied	Evidence provided by 1 or more well-designed clinical studies in which interobserver and intraobserver reliability is represented by a \bar{A} , statistic of 0.40–0.60

Class	Therapeutic Studies: Investigating the Results of Treatment Prospective ^d comparative study ^e	Diagnostic Studies: Investigating a Diagnostic Test reference "gold" standard) Systematic review ^b of Class II studies	Clinical Assessment: Studies of Reliability and Validity of Observations, Including Clinical Examination, Imaging Results, and Classifications on an intraclass correlation coefficient of 0.50–0.70
	Systematic review ^b of Class II studies or Class I studies with inconsistent results	Study of nonconsecutive patients; without consistently applied reference "gold" standard	
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^bA combination of results from 2 or more prior studies.

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^ePatients treated 1 way (e.g., halo vest orthosis) compared with a group of patients treated in another way (e.g., internal fixation) at the same institution.

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^hPatients treated 1 way with no comparison group of patients treated in another way.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Selected articles were carefully reviewed by the authors. Evidentiary tables were created (refer to Tables 2 and 3 in the original guideline document) that reflected the strengths and weaknesses of each article.

On occasion, the assessed quality of the study design was so contentious and the conclusions so uncertain that the guideline authors assigned a lower medical evidence classification than might have been expected without such a detailed review. In every way, adherence to the Institute of Medicine's criteria for searching, assembling, evaluating, and weighing the available medical evidence and linking it to the strength of the recommendations presented in this document was carried out.

Articles that did not achieve immediate consensus among the author group were discussed extensively until a consensus was reached. Very few contributions required extensive discussion. Most articles were easily designated as containing Class I, II, or III medical evidence using the criteria set forth by the author group at the initiation of the literature evaluation process (see the "Rating Scheme for the Strength of the Evidence" field).

Methods Used to Formulate the Recommendations

Description of Methods Used to Formulate the Recommendations

The current author group was selected for its expertise in spinal surgery (both neurosurgical and orthopedic), neurotrauma, clinical epidemiology, and, in several cases, prior experience with guideline development. The topics chosen for inclusion in this iteration of these guidelines are contemporary and pertinent to the assessment, evaluation, care, and treatment of patients with acute cervical spine and/or spinal cord injuries.

Rating Scheme for the Strength of the Recommendations

Levels of Recommendation

Level I	Generally accepted principles for patient management, which reflect a high degree of clinical certainty (usually this requires Class I evidence which directly addresses the clinical questions or overwhelming Class II evidence when circumstances preclude randomized clinical trials)
Level II	Recommendations for patient management which reflect moderate clinical certainty (usually this requires Class II evidence or a strong consensus of Class III evidence)
Level III	Other strategies for patient management for which the clinical utility is uncertain (inconclusive or conflicting evidence or opinion)

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate management of isolated fractures of the axis in adults

Potential Harms

- Halo immobilization is associated with a number of known complications, including but not limited to pin loosening, infection, cranial fracture,

pressure sores, poor patient compliance, pulmonary issues, pneumonia, and restricted patient mobility.

- Perioperative complications, including death, may occur with surgical fixation and fusion, especially in the elderly.
- The ability of elderly patients to tolerate halo fixation immobilization has been questioned. Mortality rates as high as 26% with the use of the halo device have been reported.

Qualifying Statements

Qualifying Statements

- Medical evidence-based guidelines are not meant to be restrictive or to limit a clinician's practice. They chronicle multiple successful treatment options (for example) and stratify the more successful and the less successful strategies based on scientific merit. They are not absolute, "must be followed" rules. This process may identify the most valid and reliable imaging strategy for a given injury, for example, but because of regional or institutional resources, or patient co-morbidity, that particular imaging strategy may not be possible for a patient with that injury. Alternative acceptable imaging options may be more practical or applicable in this hypothetical circumstance.
- Guidelines documents are not tools to be used by external agencies to measure or control the care provided by clinicians. They are not medical-legal instruments or a "set of certainties" that must be followed in the assessment or treatment of the individual pathology in the individual patients we treat. While a powerful and comprehensive resource tool, guidelines and the recommendations contained therein do not necessarily represent "the answer" for the medical and surgical dilemmas faced with many patients.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Mobile Device Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Ryken TC, Hadley MN, Aarabi B, Dhall SS, Gelb DE, Hurlbert RJ, Rozzelle CJ, Theodore N, Walters BC. Management of isolated fractures of the axis in adults. In: Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery. 2013 Mar;72(Suppl 2):132-50. [103 references] [PubMed](#)

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2013 Mar

Guideline Developer(s)

American Association of Neurological Surgeons - Medical Specialty Society

Congress of Neurological Surgeons - Professional Association

Source(s) of Funding

Congress of Neurological Surgeons

Guideline Committee

Guidelines Author Group of the Joint Section of Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons

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Financial Disclosures/Conflicts of Interest

The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this guideline.

Guideline Status

This is the current release of the guideline.

Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) and EPUB for eBook devices from the [Neurosurgery Web site](#)

Availability of Companion Documents

The following are available:

- Foreword. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):1. Electronic copies: Available in Portable Document Format (PDF) from the [Neurosurgery Web site](#) .
- Commentary. Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):2-3. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .
- Introduction to the guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):5-16. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .
- Methodology of the guidelines for management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;72(3):17-21. Electronic copies: Available in PDF from the [Neurosurgery Web site](#) .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on July 9, 2013. The information was verified by the guideline developer on October 3, 2013.

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